

Low Cost Upper Stage (LCUS) Propulsion Project

Game Changing Development Program | Space Technology Mission

Directorate (STMD)



ANTICIPATED BENEFITS

To NASA funded missions:

Existing additive manufacturing (AM) equipment combined with new, enabling processes, and manufacturing 'best practices' will make it possible for more companies to build high quality rocket propulsion hardware at a lower cost and faster delivery than previously possible. These cost and schedule savings will be passed along to NASA when a new rocket engine is competed. AM can potentially offer an order of magnitude savings of cost and schedule for complex rocket propulsion hardware. AM process development for copper alloy, materials characterization, and technology transfer to industry will open new competitive markets that may reach beyond the space flight industry. Provide space industry with new material property database and proven techniques for implementing AM in their manufacturing process.

DETAILED DESCRIPTION

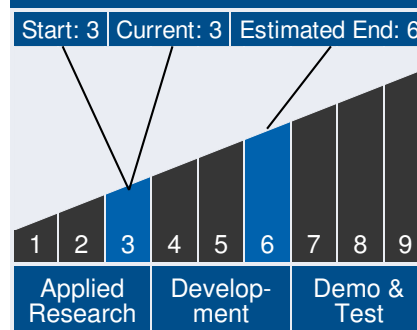
The LCUSP will demonstrate the ability to produce a low cost upper stage-class propulsion system using additive manufacturing technologies. LCUSP will do this by (1) developing a copper alloy additive manufacturing design process, (2) building a 25K-class regenerative chamber and nozzle, (3) testing components individually, and (3) demonstrating as a system in a hot fire resistance test.



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Technology Maturity

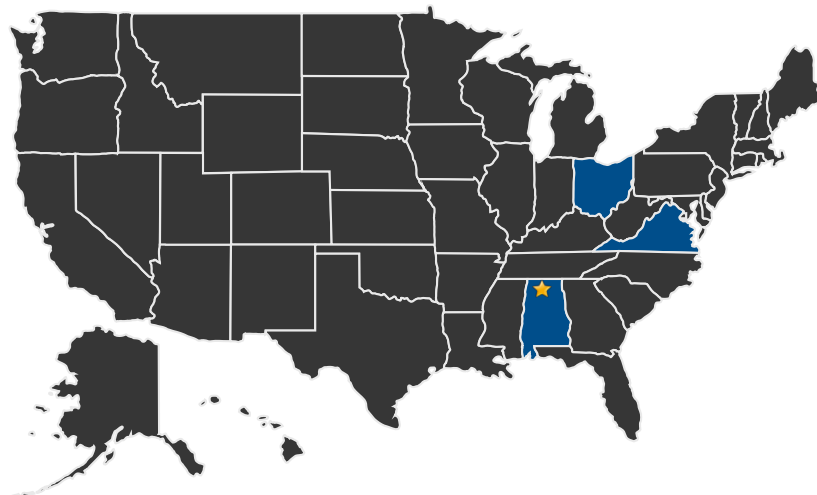


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U.S. WORK LOCATIONS AND KEY PARTNERS



■ U.S. States
With Work

★ **Lead Center:**
Marshall Space Flight Center

Other Organizations Performing Work:

- Allegheny Technologies, Inc.

LATEST SUCCESS STORY

NASA 3-D Prints First Full-Scale Copper Rocket Engine Part

PROJECT LIBRARY

Success Stories

- NASA 3-D Prints First Full-Scale Copper Rocket Engine Part
 - (<http://techport.nasa.gov:80/file/16653>)



Management Team

Program Executive:

- Lanetra Tate

Program Manager:

- Mary Wusk

Project Manager:

- John Vickers

Principal Investigator:

- Lanetra Tate

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Technology Areas

Primary Technology Area:

Launch Propulsion Systems (TA 1)

- └ Ancillary Propulsion Systems (TA 1.4)
 - └ Main Propulsion Systems (Excluding Engines) (TA 1.4.2)
 - └ Advanced, Low-Cost Cryogenic and Rocket Propellant (RP) Components (TA 1.4.2.1)

─ Materials, Structures, Mechanical Systems and Manufacturing (TA 12)

- └ Manufacturing (TA 12.4)
 - └ Manufacturing Processes (TA 12.4.1)
 - └ Innovative Metallic Process (TA 12.4.1.1)

Secondary Technology Area:

In-Space Propulsion Technologies (TA 2)

- └ Supporting Technologies (TA 2.4)
 - └ Materials and Manufacturing Technologies (TA 2.4.3)

─ Materials, Structures, Mechanical Systems and Manufacturing (TA 12)

- └ Materials (TA 12.1)

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Technology Areas (cont.)

Additional Technology Areas:

Materials, Structures, Mechanical Systems and Manufacturing (TA 12)

- └ Materials (TA 12.1)
 - └ Lightweight Structural Materials (TA 12.1.1)
 - └ Smart Materials (TA 12.1.1.3)

DETAILS FOR TECHNOLOGY 1

Technology Title

Low Cost Upper Stage-Class Propulsion System

Technology Description

This technology is categorized as a hardware component or part for ground scientific research or analysis

This technology is categorized as a hardware system for ground scientific research or analysis. The technology will:

- Develop critical components for an Upper Stage-Class Propulsion System and demonstrate with testing
- Develop high strength copper alloy additive manufacturing process
- Build a 25K-class regen chamber and nozzle to be used with the previously tested DMLS injectors
- Test an AM throttleable turbopump

Capabilities Provided

- Emerging AM technologies can significantly reduce development time and cost for complex rocket propulsion hardware
- NASA developed AM technology will be made available to the AM manufacturing industry providing wide supplier base
- Develop AM materials that are rocket specific

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Capabilities Provided (*cont.*)

- Build and test an upper stage class chamber and nozzle, and a throttlable turbopump using AM manufacturing
- Provide AM technology to both the AM and commercial space industries.

Potential Applications

The LCUSP element is complimentary and directly relevant to the continued development of the SLS capability by pursuing affordability improvements for engines and stages.